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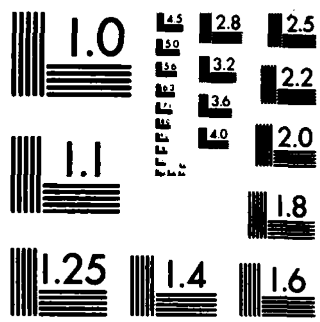

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NAVAL POSTGRADUATE SCHOOL

Monterey, California

WEARING ARMY GAS MASKS WHILE TALKING

TO A VOICE RECOGNITION SYSTEM

by

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March 1983

Approved for public release; distribution unlimited.

Prepared for:
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This report describes an experiment in which Army personnel wore a gas mask while entering verbal commands to a voice recognition system. The results indicate that, with the equipment used, recognition performance is certainly not acceptable for field use at this time. Further research would be needed on this interface of technologies in order to provide user acceptable voice recognition accuracies.

ABSTRACT

The need for voice recognition users to wear protective masks in conjunction with voice input duties is becoming important in both the military and industrial communities. For example, the Army is interested in using voice recognition input for a Tactical Fire Control Computer System (TACFIRE) in the field. It is essential that both the capability to protect the user from a chemical warfare environment and voice recognition accuracy be maintained. Likewise, in some voice input applications, such as a command post, situations exist when it is desirable to enter all voice input commands silently. In both examples, some type of protective mask (i.e., gas mask or stenographer's mask) would be used in conjunction with voice recognition equipment.

A previous study tested an easily removable protective mask called a Stenographer's mask in conjunction with a Threshold Technology, Inc., T600 voice recognition unit. This paper will present the results of the second half of the protective mask study conducted at the Naval Postgraduate School. This particular research was conducted to investigate the recognition accuracy of a different currently available voice recognizer using an Army gas mask. Of particular concern was the need to determine if the algorithms and equipment could handle the expected voice resonance and forced breathing sounds associated with the nonremovable protective mask without any significant degradation in recognition capability. This study tested subjects under various microphone and mask conditions.

TABLE OF CONTENTS

I. INTRODUCTION

In recent years, voice technology has developed to the extent that basic systems have now been used successfully in several industrial and military applications. With constant improvements being made in the capabilities of voice recognition systems, their use in a wider variety of settings is already being contemplated. Within the last year, two independent requests have been made to the researchers at the Naval Postgraduate School to investigate the capability of voice recognition systems to be used in conjunction with several types of protective masks.

The first request came from users of a voice recognition system located in a Command Control and Communication (C^3) center in Hawaii. They had successfully used one system to run daily computer queries on the current status of naval forces. The command center staff was considering the use of voice input on several terminals in order that numerous queries could be made at once. Furthermore, the staff was investigating the possibility of using voice to operate a newly planned computer system used to generate graphic situation displays.

One primary concern of the staff was the interference of voice input to the efficient operation of the command center. The terminal presently used has been isolated in a room adjacent to the main command center, but the additional new equipment would be placed directly in the command center. Although recent research (Elster 1980) showed that background noise (including speech) did not interfere significantly with voice recognition accuracy, little research has been conducted on the effectiveness of voice in larger installations where several speakers, each operating a separate recognizer, may be required to make inputs simultaneously. It is conceivable that, under those conditions, the speakers or operators themselves might become confused by each other's speech, thus perhaps increasing input errors. Confusing situations could also be created during command briefings when the computerized situation display is operated by voice. The voice input might interfere with the high level briefings being conducted as the displays are generated.

These two situations could produce unwanted effects on the command center, especially during crisis situations. One way to reduce the effects of operator confusion and/or interference with other command center operations is to have each speaker direct his or her commands into a mask, so that little if any recognizable sound escapes into the speaker's immediate environment. Hence, the probability of disturbing or confusing a nearby speaker may be reduced markedly, and interference with other command center operations eliminated.

The second inquiry about using voice recognition systems in conjunction with masks came from an Army field artillery group in Oklahoma and the Army's High Technology Testbed Project at Fort Lewis, Washington. After a 15 minute demonstration of voice input to the Army's computerized Tactical Fire Control Computer (TACFIRE), the group started to formulate future voice input requirements for TACFIRE. At present, voice input is only being considered for use in a mobile but fairly stable computer center at the Division level. This group of Army officers was interested in starting the research needed to determine the feasibility of using voice input at mobile terminal sites used by lower command levels and usually located in a more hostile environment than the Division level counterpart. The problems which must be overcome before voice can be determined effective in such a stressful environment are numerous. The problems include mobility and size of the recognition unit, multiple user capability, and the ability to operate in all warfare environments. The chemical warfare environment is of particular concern since it would require the use of voice recognition systems in conjunction with gas masks.

Therefore, the question at issue is: How well will current voice recognition equipment perform under "masked" conditions such as those described above? Specifically, does the impressive accuracy rate ascribed to currently available voice recognition equipment suffer significantly if the user is required to enter utterances to the system through a mask, as opposed to the conventional "boom" microphone mounted on a headset?

In order to answer this question, two independent but similar experiments were conducted. The first experiment used a stenographer's mask similar to the one that is envisioned for use in the command center. It is interesting to note that the steno mask tested is also used by the Marine Corps to muffle voice communications when operating close to enemy positions. The results from this experiment therefore have direct application to both the command center and Army problems.

The detailed results of the stenographer's mask experiment are described in Poock, Schwalm and Roland, 1982. The experiment showed that the mask caused a statistically significant increase in the misrecognition rate. The increase in misrecognitions appeared to be highly dependent on the experience level of the user with respect to speaking into and using masks and microphones. For the subjects, such as pilots, who considered themselves experienced mask and microphone users, the increase in error rate (although statistically significant) was not practically significant. The error rate for this group of subjects was still under 2%, and would not degrade the efficient use of voice recognition equipment with the stenographer's mask.

The second experiment, which is the subject of this research report, was conducted for two reasons. The first and most important objective was to establish whether or not a more restrictive protective mask had a large effect on the recognition error rate. The stenographer's mask was manually held in place over the nose and mouth by the subject. Therefore, the mask was easily removed to take large breaths or for comfort. The more restrictive mask used was an Army M24 field protective mask.

The second objective of the experiment was to test a different recognizer for its suitability with protective masks. A direct comparison of two different recognizers was not the objective, but a different recognizer was chosen to investigate the algorithm differences which might enhance or degrade the protective mask recognition rate.

As background, the recognizer and gas mask used will be discussed. Secondly, the experimental design will be presented, followed by the results of the experiment. The analyzed data left some questions unanswered, so a short side experiment was conducted to determine whether or not further experimentation is warranted. This small test will be described, ending with the conclusions and recommendations of the second half of the study to analyze the use of protective masks and voice recognition equipment.

II. RECOGNIZER AND GAS MASK CHARACTERISTICS

Recognizer

An Interstate Electronics Corporation VRT101 Voice Recognition System was used. The VRT101 is a user dependent, discrete utterance, board level recognizer. The recognition board is accessed in conjunction with a Heath Zenith Z80 based 8 bit microprocessor. The recognizer has a 100 utterance capacity. One word is reserved for a word correction capability which leaves 99 words available for specific user definition. The correction capability allows the user to easily erase, through a voice command, the results of the last voice input command.

The Interstate system has the capability to set various utterance rejection levels. The first is the reject threshold level which is used to discard words whose algorithm score is not greater than or equal to the threshold value set. The reject level was set to 85, as suggested by Interstate Electronics, and this setting caused only 13 nonrecognitions throughout the entire experiment. The second variable set was the delta value. This value is used to reject an utterance when the difference between its classification score and the runner up's classification score is less than or equal to the selected value. Since there was no data on what an appropriate value for this variable should be, it was set to zero, which allowed all voice inputs not to be rejected because of a close runner-up. Delta level data was collected during the experiment for each utterance for analysis purposes. Therefore, since there was such a small number of nonrecognitions, only the misrecognition data was analyzed and is presented here. The initial delta level analysis is also provided.

In order to access the delta level data, a program was written to pull the recoqnized word off the parallel port of the recognition board. This program made use of several FORTRAN subroutines supplied by Interstate Electronics. A copy of the program is in Appendix A. To fully understand the details of the program, the VRT101 system documentation should be consulted.

Basically, the program is designed to wait for information on the recognitioner's parallel port, decipher the information, and display the work and delta value information on the CRT screen for manual data collection.

Gas Mask

The gas mask used is the M24 field protective mask used by tank operators in the Army. This particular gas mask comes equipped with an internally mounted microphone that is placed directly in front of the mouth, slightly below the user's bottom lip. The air hose for the gas mask is to the left of the microphone and is placed at the same height. It is believed that the placement of the microphone and air hose are in the worst possible positions and the data collected should represent a lower bound. In other words, the recognition accuracy would probably increase if the equipment was specially designed for use with voice recognition equipment.

The experiment tested two different microphones mounted in the gas mask. The first microphone was the original gas mask microphone, which was an Electro Voice, Inc., Microphone Dynamic M118. No documentation was available on its performance characteristics.

The second device used was the Shure SM10 noise cancelling pressure differential microphone. Since this microphone works on a pressure differential between the top and bottom of the microphone to distinguish surrounding noise from the utterance, special care had to be taken to mount the microphone properly. The mounting technique used required that enough space be left open underneath the microphone to allow for the pressure differential characteristics required for proper operation. This resulted in the microphone being placed higher in the microphone housing and thus closer to the user's mouth than the original gas mask microphone. This, unfortunately, could not be avoided without redesigning the entire mask assembly which was outside the purview of the experiment.

III. EXPERIMENTAL DESIGN

Twelve subjects (5 males, 7 females) participated in this experiment. One female subject was a volunteer and was an experienced voice recognition user. The other 11 subjects were Army enlisted personnel assigned to Fort Ord, California. All 11 enlisted subjects had never seen voice recognition equipment before, and 6 of the 11 had little or no interaction with computers. They did not volunteer for the experiment, but were assigned to participate in addition to their normal military duties. Their ages ranged from 19 to 39, with a median age of 23.

A 6X3X6 mixed design with repeated measures on two factors was employed in this experiment. The first factor, order of mask use, was the between variable, and was composed of the 6 orders in which all three masks could be used by each subject; subjects were nested within this variable so that three subjects received one of each of the six possible "mask" orders. This counterbalancing scheme was adopted to control any effects that order of use may have contributed to the results. "Mask condition (N=No Mask, O=Original Mask, S=Shure Mask) was a three-level, within group variable with each subject performing under each of the three "mask" conditions. Each subject also performed 6 trials with each mask, making trials the second within group variable with 6 levels. A summary of the experimental design appears in Figure 1.

The full utterance capacity of the VRT101 system was used in the experiment. The word list used contained utterances necessary to input information to the Army's Tactical Fire Control System (TACFIRE). The update fire unit message template was chosen as a typical TACFIRE application and the vocabulary was developed to fulfill that specific template requirement. The TACFIRE application was used because it is the basis for the gas mask experiment. The words developed and used are listed in Appendix B.

For training, each subject repeated the 100 word vocabulary list in sequential order 7 times. This was the manufacturer's suggested number of passes. Because of time and subject availability, all training passes took place during one sitting instead of training over a longer period of time as suggested by the manufacturer. Each subject trained the entire vocabulary on Monday. This took about 45 minutes. Immediately after training, subjects made at least two passes through the entire 100 word vocabulary (essentially a test session) to identify any problems in the training of a particular utterance. When the system produced correct responses on those two passes, the utterance was considered adequately trained. If errors occurred, a third pass was made. If less than two of three passes of any utterance was correct, that utterance was retrained. It should be noted that there were 5 times during the 3 week period (all under the gas mask conditions) when the test could not be passed adequately for all of the words. In these five cases, all words were recognized at least once, and the test failed for a maximum of 6 words for any one subject even after numerous tries at retraining.

After training, subjects tested the system. Each subject was scheduled to make two passes through the entire vocabulary list on each of three successive days. These testing sessions were administered on Tuesday, Wednesday and Thursday of the same week in which training took place. Thus, a total of six testing trials were run for each subject under each "mask" condition. In this way, subjects were able to complete training and testing on one mask condition within one week. The experiment ran for a total of three weeks, with one mask condition being run each week.

The independent variable in this study was "mask" condition: No Mask, where subjects trained and tested the system using the conventional "boom" microphone; the Original Mask, where subjects trained and tested the gas mask containing the standard microphone supplied by the manufacturer; and the Shure Mask, where subjects trained and tested the gas mask containing the Shure SM10 microphone.

The dependent variables in this study were misrecognitions. There were few nonrecognitions; therefore, they were not considered in the analysis.

At the conclusion of the experiment, each subject was asked to fill out a questionnaire designed to measure certain attitudes and experience variables that the researchers felt might affect performance. A copy of the questionnaire is in Appendix C.

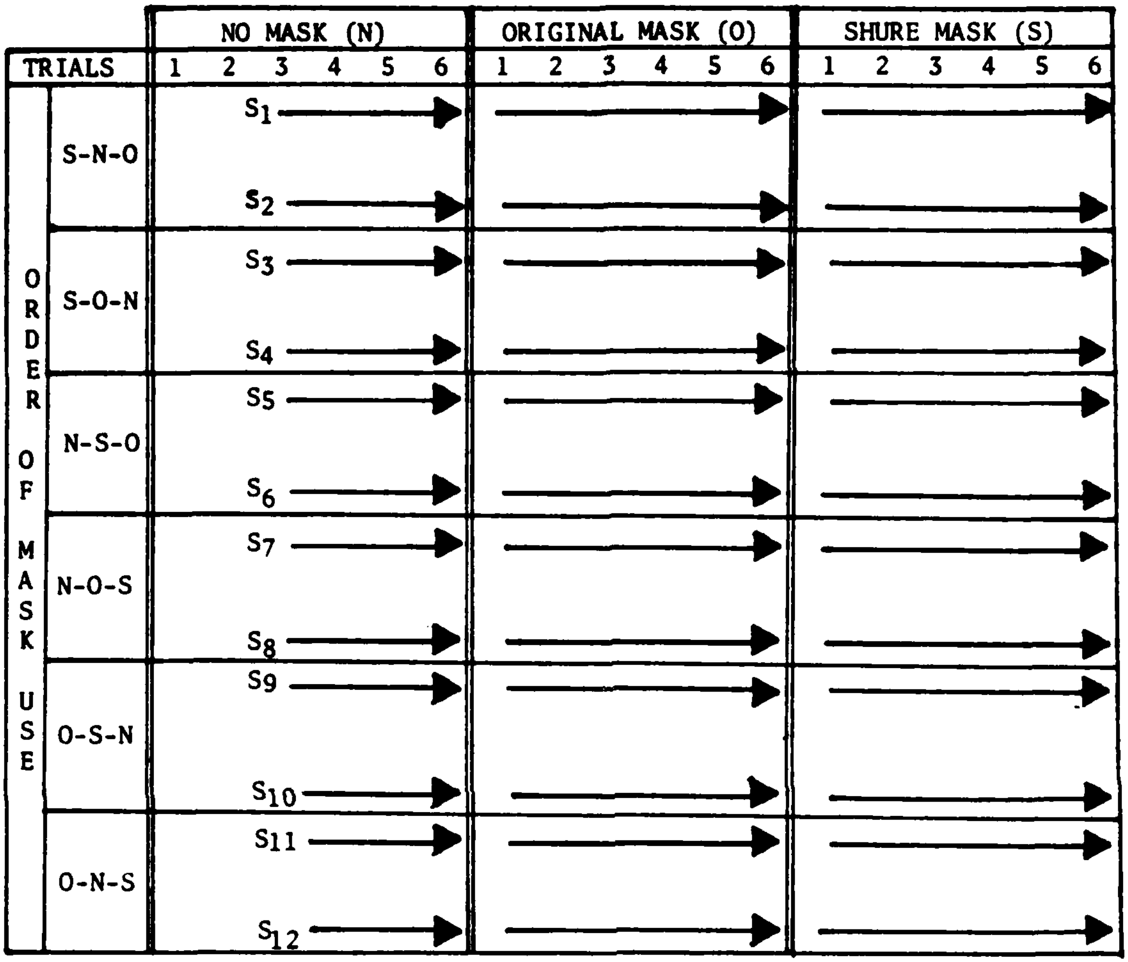

FIGURE 1. SUMMARY OF EXPERIMENTAL DESIGN

IV. ANALYSIS

All analyses were performed using the SPSS (Nie, Hull, Jenkins, Steinbrenner and Bent, 1975) and BMDP (Broen, Engelman, Frame, Hill Jenurich and Toporek, 1981) statistical packages. All repeated measures analyses of variance procedures were performed using the arcsin transformation of raw data to stabilize the variance of the error terms (Neter and Wasserman, 1974). The mean error rates that appear in the figures, however, are untransformed. All posterior tests for significance between pairs of means were performed using the Scheffe procedures described in Bruning and Kintz (1977).

Table 1 presents the analysis of variance summary for misrecognitions. Significant main effects of mask condition ($F = 8.97$, $P < .01$) is evident, as is a slight mask and trial interaction ($F = 2.16$, $P < .04$). This mask-trial interaction is indicated in a review of Figure 2, where there is a definite degradation in performance for the No Mask condition in week 5 and 6, but no apparent degradation for the other gas mask conditions. It is interesting to note that a similar performance trend was reported for the No Mask condition in the Stenographer's mask experiment. Although very slight, this phenomenon has not been thoroughly explained.

With regard to the main effect of mask condition, a Scheffe test for significance between pairs of means was performed. The results of these tests indicated a significant difference existed between all pairs of mask conditions. Table 2 presents the calculated 95% confidence interval for the estimated misrecognition rate difference between all 3 paired mask conditions.

Table 3 presents a summary by subject of the data collected. The error rates, to say the least, are unacceptably high. The No Mask error rate of 7.7% is extremely high for Interstate performance, but can be explained by the attitude of two of the participants and the new vocabulary list used. If subjects 10 and 11 are removed from the table as outliers, the mean error rate for the No Mask condition becomes 5.3%. This error rate is consistant with rates reported by Interstate for a full 100 word vocabulary. Furthermore, there were 7 words which had an unusually high error rate and it is felt that simple utterance changes for these words would bring the error rate down.

Even though there are possible vocabulary changes which might improve recognition, the large increase in error rate for the masked condition can not be easily pinpointed. Further research must be conducted to determine the exact cause of the extremely high error rates recorded for the gas masks. Possible causes include the following items.

Source of Variance	DF	MS	F
Order (O)	5	.691	0.84
Error	5	.818	-
Mask Condition (M)	2	2.542	8.97**
M X O	10	.305	1.08
Error	12	.283	-
Trials (T)	5	.005	0.31
T X O	25	.010	0.56
Error	30	.018	-
M X T	10	.024	2.16*
M X T X O	50	.005	0.43
Error	60	.011	-

**p .01

*p .04

TABLE 1.

ANALYSIS OF VARIANCE SUMMARY TABLE FOR TOTAL ERRORS.

Mask pair	Confidence interval
No mask - Shure mask	(.08,.10)
No mask - Original	(.11,.13)
Shure mask - Original	(.019,.04)

TABLE 2

95% CONFIDENCE INTERVAL FOR PERCENT DIFFERENCE BETWEEN MASK CONDITIONS

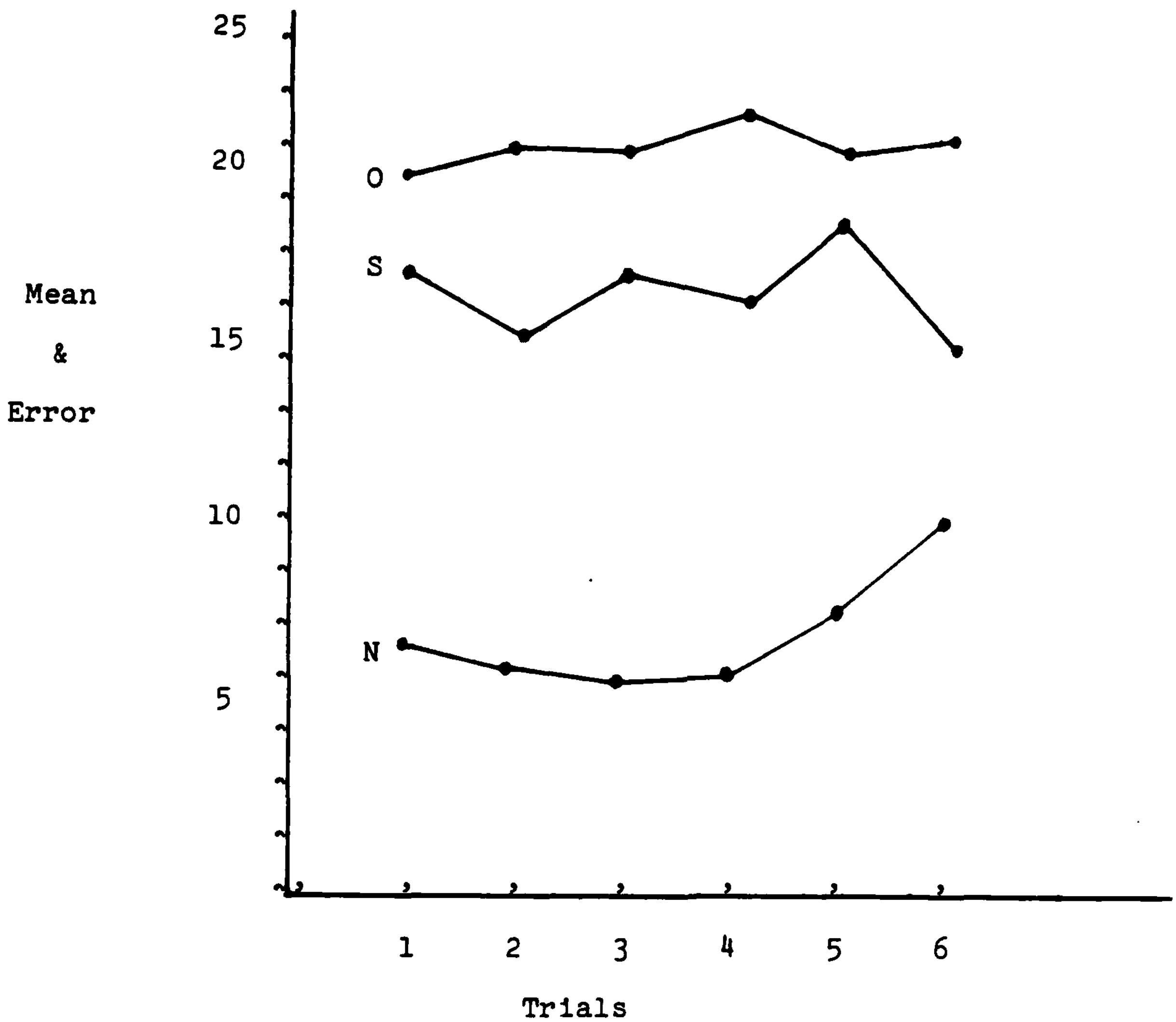

FIGURE 2. TOTAL ERROR RATES BY MASK CONDITIONS BY TRIALS

Subject	No Mask	Shure Mask	Original mask
1	4.50	13.33	12.67
2	6.67	27.83	25.33
3	6.17	5.00	4.67
4	4.50	16.17	19.17
5	5.33	5.83	43.50
6	6.83	35.83	34.83
7	5.67	11.33	6.00
8	5.83	15.83	9.50
9	3.50	7.50	9.67
10	16.67	16.50	34.83
11	23.17	19.83	24.00
12	4.00	28.50	17.50
$\overline{X}$	7.74	16.96	20.14

TABLE 3.

MEAN TOTAL ERROR RATES (IN PERCENT) FOR MASK CONDITIONS BY SUBJECT

Mask Condition	Delta value = 0	Delta value = 2
N	4.5/0	1.17/10.33
S	13.3/0	3.67/20.83
O	12.6/0	2.67/30.17

TABLE 4.

MISRECOGNITION/NONRECOGNITIONS AT VARIOUS DELTA LEVELS

1. The front mounted microphone was placed extremely close to and directly in front of the mouth and resulted in what is believed to be the worst possible position for the microphone, especially for fricatives.

2. The breathing hose connected to the mask filter for incoming air was placed directly next to the microphone. This caused noise at the beginning and ending of words as the user took a breath immediately before and after the utterance.

3. There is an outgoing air valve directly below the microphone. This valve is covered by a small piece of rubber. As the speaker breathes out, the valve opens, displacing the external protective piece of rubber. When the valve closes, the piece of rubber falls back over the valve opening. After the mask has been used for a period of time, a distinct popping sound is caused by the rubber piece being snapped back over the valve opening. This sound could happen during an utterance, immediately following the hard consonant sounds, such as "p" and "t".

4. User attitudes encountered might have an effect, not only on the use of voice recognition under protective mask conditions, but the use of the technology in general. Some subjects became frustrated easily and did not attempt to observe the simple techniques that they were taught for the purpose of maximizing recognition accuracy. The poor attitude encountered could be due to the requirement of wearing the uncomfortable protective mask, the fact that the experiment was a required additional duty for the subjects, or resistance of the subjects to accept the new technology.

5. The mask was not always adjusted snuggly against the user's face in the user's attempts to make it easier to breathe.

6. The Interstate word boundary parameters might be adjusted to facilitate the automatic "chopping" off of breath sounds at the beginning and ending of each utterance.

7. The Interstate algorithms are not suited for this particular application.

As a positive note, five of the 12 subjects (Subjects 3, 5, 7, 8, & 9) achieved some relatively acceptable error rates (under 10%) for all masked conditions. Subject 5 had a cold during the original mask condition and had an extremely high error rate. It should also be noted that all five of these subjects rated themselves as very experienced in the use of masks or microphones.

Finally, the number of misrecognitions will be reduced or at least replaced by nonrecognitions if the Interstate delta value was set to other than 0. Table 4 summarizes the delta level data collected for Subject 1. The misrecognition rate is drastically reduced, but is replaced by an inordinate number of nonrecognitions even in the No Mask condition. This is definite evidence of utterance similarity which hopefully can be reduced by modification of the word list.

The average delta value for the No Mask condition was 10.4. While the average delta value for the original and Shure Mask was 6.7 and 6.2, respectively. This can be interpreted as a real problem with the use of the gas mask and voice recognition technology. The poor recognition rate achieved goes beyond the utterance list used and the experience level of the subject. For the Interstate equipment, there is a definite degradation in the algorithm's ability to distinguish between utterances when the gas mask is used.

V. THRESHOLD TEST

The previous section suggested numerous possible explanations for the poor recognition rate achieved in this experiment. The majority of the reasons outlined concerned the mask design, and user attitudes and procedures. The remainder of the hypothesized problem areas concerned the vocabulary list that was developed especially for this experiment and the Intestate Electronics equipment.

In order to determine which hypothesized problem area contributed the most to the error rate demonstrated, several independent experiments must be run, along with the professional development of a proper mask apparatus. Before any suggestions are made that money and time should be spent on the redesign of the protective mask, a very quick pilot experiment was conducted to determine whether the vocabulary list and/or recognition equipment was a major contributor to the error rate.

This pilot experiment consisted of one subject repeating the experiment, using the same vocabulary list. but using the Threshold Technology, Inc., Model T600 recognition system instead of the Innterstate Electronics VRT100. The subject, number 9, was the experienced recognition user who was a volunteer for the main experiment. The experiment is just a pilot study and is not presented as representing statistically significant results.

The results can be simply stated. For the No Mask condition, there were only 4 errors (all misrecognitions) out of the 600 utterances. This represented a 99.3% accuracy rate. The original mask and Shure mask conditions produces 92.7% and 91.84% accuracy rates, respectively. These accuracy rates are comparable to the rates achieved with the Interstate equipment for the mask conditions.

The above pilot study leads the authors to believe that the vocabulary list has few inherent recognition problems without the mask. The accuracy rates achieved for the masked conditions were very close to an inefficient level. Therefore, mask redesign appears to be the next step, since both recognition units had severe problems when the gas mask was used.

Conclusions

The results of the present study are not very encouraging. In the first experiment, it is apparent that, although using a stenographer's mask does contribute to an increase in the percent of misrecognition errors made, this increase in errors may be mitigated to a large extent by experience using masks or microphones. This led the authors to suggest that, with appropriate training, "masked" speakers could achieve an accuracy rate comparable to "unmasked" speakers, using currently available voice recognition equipment. In this second experiment, where the masked condition is much more severe since the mask can not be easily removed to take a breath, much more research needs to be done. Experience also proved to be an important factor, but the error rate even from experienced users was higher than the results using the stenographer's mask. Areas for further research are the placement of the microphone in the mask, and variation of word boundary parameters to help alleviate the breathing sound problems which usually occur at the beginning and ending of words, and might be responsible for utterance similarity.

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APPENDIX A

RECOGNITION PROGRAMS

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RECOGNITION PROGRAMS

```
 TYPE GAS.FOR
      DIMENSION IBUF(28),NODE(14)
      IBELL = Z'07'
      DO 100 I = 1,14
         NODE(I) = Z'2020'
 100  CONTINUE
      IER = 0
      NODE(1)='NA'
      NODE(2)='VY'
      CALL PRCSYN(NODE,IER)
      IF(IER .NE. 1) GO TO 999
      DO 1000 ITRIAL = 1,2
         DO 2000 IWORD = 1,1000
            CALL VRMIN(IDUM)
            CALL VRMIN(IDUM)
            CALL VRMIN(IWN10)
            CALL VRMIN(IWN1)
            IF(IWN10 .EQ. 70 .AND. IWN1 .EQ. 70) GO TO 5000
            CALL VRMIN(IDS10)
            CALL VRMIN(IDS1)
            CALL VRMIN(IS100)
            CALL VRMIN(IS10)
            CALL VRMIN(IS1)
            CALL VRMIN(IRU10)
            CALL VRMIN(IRU1)
            DO 2100 I = 1,28
               IBUF(I) = Z'2020'
2100        CONTINUE
            ITST = 47
            IBS = 1
            IBF = 14
            ASSIGN 150 TO IDIS
 130        DO 2200 K = IBS,IBF
               CALL VRMIN(IDUM)
               IF(IDUM .EQ. ITST) GO TO IDIS
               IBUF(K) = IDUM
               CALL VRMIN(IDUM)
               IF(IDUM .EQ. ITST) GO TO IDIS
               IBUF(K) = IBUF(K) + IDUM * 256
2200        CONTINUE
            GO TO IDIS
```

APPENDIX A

RECOGNITION PROGRAMS

```
 150         IBS = 15
             IBF = 28
             ITST = 13
             ASSIGN 160 TO IDIS
             GO TO 130
 160         IDS = (IDS10 - 48) * 10 + (IDS1-48)
             IF(IWN10 .EQ. 70 .AND. IWN1 .EQ. 70) GO TO 5000
             WRITE(3,903) (IBUF(I),I=1,14),IDS,(IBUF(I),I=15,28)
             GO TO 2000
5000         DO 5100 IC = 1,40
             CALL VRMIN(IDUM)
             IF(IDUM .EQ. 13) GO TO 5200
5100         CONTINUE
5200         WRITE(3,904)
             WRITE(3,905) IBELL
2000      CONTINUE
          WRITE(3,902)
1000  CONTINUE
      GO TO 9999
 999  WRITE(3,901)
9999  STOP
 901  FORMAT(1X,'ERROR ENTERING PARALLEL MODE'/)
 902  FORMAT(1X,'ONE MORE PASS THROUGH THE VOCABULARY')
 903  FORMAT(1X,14A2,3X,I3,3X,14A2/)
 904  FORMAT(1X,'NO MATCH'/)
 905  FORMAT(3X,A2)
      END
```

APPENDIX B

VOCABULARY LIST

NAVY;
A7 DELTA;
OUT UNTIL;
M-91;
BEARING SIGHT;
2;
A7 ECHO;
6;
ECHO 1;
7;
3 INCH 50;
AVAIL SUPPLY RATE;
M-102;
M-110;
GRID ZONE;
XM-740;
M-109;
AMMUNITION UPDATE;
RADIATION;
REINFORCING;
HONEST JOHN;
5 INCH 38;
NUCLEAR;
DIRECT SUPPORT;
M-114;
6 INCH 47;
5 INCH 54;
A4 MIKE;
0;
FORCE SUPPORTED;
HIGH EXPLOSIVE;
A4 ECHO;
F4 JULIETT;
1;
SITUATION REPORT;
SPHEROID;
M-107;
105 MILLIMETER;
HERCULES;
REINFORCED UNITS;
REACTION TIME;
ALL WEAPON TYPES;
XM-752;
DAY;
GENERAL SUPPORT;
CRITICAL AMMUNITION;
F4 DELTA;
MINIMUM RANGE;
175 MILLIMETER;

APPENDIX B

BASIC LOAD;
CHEMICAL;
A6 ECHO;
CANNON;
PERSHING;
RETURN;
A7 CHARLIE;
MINUTE;
DELETE REQUEST;
RESPONSE TIME;
UPDATE FIRE UNIT;
3200 SIGHT;
LANCE;
8;
8 INCH;
M-108;
NUCLEAR REPORT;
MISSILE ROCKET;
WEAPON STRENGTH;
6400 SIGHT;
8 INCH 55;
NONNUCLEAR REPORT;
GENERAL;
4;
BUILD A PLAN;
F4 BRAVO;
A6 ALPHA;
COORDINATES;
3;
ALPHA 2;
A- 10;
HOUR;
WEAPON TYPE;
AIR;
5;
F4 CHARLIE;
AZIMUTH;
USER COMMANDS;
155 MILLIMETER;
LAUNCH SITE UPDATE;
F105;
F4 ECHO;
ALPHA;
ALL;
9;
A4 FOXTROT;
F111;
ALPHA ONE;
READY;
COORDINATE EAST;

APPENDIX C

QUESTIONNAIRE

ON THE FOLLOWING PAGES YOU WILL FIND SEVERAL QUESTIONS/STATEMENTS DESIGNED TO GET YOUR REACTIONS TO USING VOICE RECOGNITION EQUIPMENT. ALSO, THERE ARE QUESTIONS REGARDING YOUR EXPERIENCE WITH VARIOUS INPUT DEVICES.

PLEASE RESPOND TRUTHFULLY, AND CHECK YOUR QUESTIONNAIRE AFTER COMPLETION TO MAKE SURE YOU'VE ANSWERED ALL THE ITEMS.

THANK YOU FOR YOUR COOPERATION AND PARTICIPATION IN THIS EXPERIMENT.

HOW MUCH EXPERIENCE HAVE YOU HAD IN USING MASKS (NOT INCLUDING THIS EXPERIMENT)?

none			some			a lot
1			4			7

HOW MUCH EXPERIENCE HAVE YOU HAD IN SPEAKING INTO MICROPHONES (NOT INCLUDING THIS EXPERIMENT).

none			some			a lot
1			4			7

HOW USEFUL DO YOU THINK VOICE RECOGNITION EQUIPMENT REALLY IS?

not at all useful			somewhat useful			very useful
1			4			7

HOW MUCH DO YOU <u>LIKE</u> VOICE RECOGNITION EQUIPMENT?

don't like it at all			like it somewhat			like it very much
1			4			7

PLEASE INDICATE THE EXTENT TO WHICH YOU AGREE OR DISAGREE WITH THE FOLLOWING STATEMENTS:

"I WOULD DO BETTER WITH VOICE EQUIPMENT IF I DIDN'T SEE OR HEAR WHEN I'VE MADE AN ERROR."

disagree strongly	neither agree nor disagree	agree strongly
7	4	1

"MAKING ERRORS WHEN USING VOICE EQUIPMENT IS FRUSTRATING."

disagree strongly	neither agree nor disagree	agree strongly
7	4	1

"I FEEL PRESSURED WHEN USING VOICE EQUIPMENT."

disagree strongly	neither agree nor disagree	agree strongly
7	4	1

"VOICE EQUIPMENT IS TOO HARD TO USE."

disagree strongly	neither agree nor disagree	agree strongly
7	4	1

"VOICE EQUIPMENT IS IMPRACTICAL."

disagree strongly	neither agree nor disagree	agree strongly
7	4	1

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8